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National Electrical Safety Code

Part 1. Rules for the Installation and Maintenance Of Electrical Supply Stations And Equipment

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NBS Handbook 110–4 (ANSI C2.4) National Electrical Safety Code, Part 4, Rules for the Operation of Electric Supply and Communication Lines and Equipment. (In preparation; for current rules see NBS Handbook H34, or pages 305–358 of NBS Handbook H30.)

NBS Handbook 81 (ANSI C2.2—1960) including Supplement No. 1 (ANSI C2.2a—1965) and Supplement No. 2 (ANSI C2.2b—1967) Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines, comprising Part 2, the Definitions and the Grounding Rules of the Sixth Edition of the National Electrical Safety Code. [Supersedes NBS Handbook H32 and Part 2 (pages 77–242), the definitions (pages 1–14), and the Grounding Rules (pages 15–30) of NBS Handbook H30.] SD Catalog No. C13.6/2:81) Price $1.75

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UNITED STATES DEPARTMENT OF COMMERCE

PETER G. PETERSON, *Secretary*

NATIONAL BUREAU OF STANDARDS
LAWRENCE M. KUSHNER, *Acting Director*

NATIONAL ELECTRICAL SAFETY CODE

Part 1. Rules for the Installation and Maintenance of Electrical Supply Stations and Equipment.

Approved by American National Standards Institute July 14, 1971 as American National Standard C2.1–1971

National Bureau of Standards Handbook 110–1

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ABSTRACT

This Handbook contains Part 1 of the National Electrical Safety Code and supersedes NBS Handbook H31 and pages 31 through 75 of the NBS Handbook H30. Part 1 of this Code covers the electric conductors and equipment in electrical supply stations along with the associated structural arrangements employed, for example, by an electrical or railway utility in the exercise of its function as a utility and accessible only to properly qualified personnel. It also covers similar electric conductors and equipment in electrical supply stations when owned by and installed in an industrial establishment, where the electrical supply stations are under the control of and accessible only to properly qualified persons. Examples of such industrial establishments are the paper and steel industries.

Key words: Electrical safety; electrical supply station; electrical utility station; high voltage safety; power station equipment; power station safety.

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FOREWORD

This Handbook contains Part 1 of the sixth edition of the National Electrical Safety Code, dealing with the construction and maintenance of electrical supply stations.

This edition of these rules is the result of a revision carried out according to the procedures of the American National Standards Institute. The revised text has had the approval of ANSI Standards Committee C2, organized in conformity with this procedure, and has been recognized as an American National Standard.

Criticism of the rules and suggestions for their improvement are invited, especially from those who have experience in their practical application. In future editions every effort will be made to improve the rules, both in the development of detail and in the modification of requirements.

Lawrence M. Kushner, *Acting Director*

PREFACE

The current edition of Part 1 of the National Electrical Safety Code was prepared by a Task Group meeting frequently over a five-year period, from 1965–1970. This standard was approved under the procedures of the American National Standards Institute, after the Institute determined that there was a consensus for approval by the organizations represented on ANSI Standards Committee C2. This Standard, designated as American National Standard C2.1–1971, supersedes C2.1–1939, which was published in National Bureau of Standards Handbooks H30 and H31.

The Code as written is a voluntary standard. However, some editions and some parts of the Code have been adopted, with and without changes, by some state and local jurisdictional authorities. To determine the legal status of the National Electrical Safety Code in any particular state or locality within a state, the authority having jurisdiction should be contacted.

In preparing the first few editions of the code, the National Bureau of Standards held meetings in many parts of the country and welcomed suggestions from everyone concerned. The Bureau reserved to itself, however, the final decision on all contested points. The procedure followed in later revisions subsequent to the establishment of the American National Standards Institute (formerly known as the United States of American Standards Institute and as the American Standards Association) differs essentially from the former practice in that final decisions as to all details are made by the standards committees formally approved by the American National Standards Institute and operating under their rules of procedure.

A representative Committee on Interpretations has been set up to prepare replies to requests for interpretation of the rules contained in the Code. Requests for interpretation should state the rule in question as well as the conditions

under which it is being applied. Interpretations are intended to clarify the intent of specific rules and are not intended to supply consulting information on the application of the Code. Requests for interpretation addressed to the Building Research Division, National Bureau of Standards, Washington, D. C. 20234, if suitable for processing, will be sent to the Interpretations Committee. After due consideration by the Committee, which may involve many exchanges of correspondence, the inquirer will be notified of its decision.

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on National Electrical Safety Code

(when final letter ballot was taken)

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SI CONVERSION UNITS

In view of present accepted practice in this country in this technological area, common U.S. units of measurement have been used throughout this paper. In recognition of the position of the USA as a signatory to the General Conference on Weights and Measures, which gave official status to the metric SI systems of units in 1960, conversion factors applicable to the U.S. units used in this paper are presented below.

Length
1 in = 0.0254* meter (m)
1 ft = 0.3048* meter (m)

Electricity
1 volt—SI Unit
1 ampere—SI Unit

Power
1 watt—SI Unit

Light
1 foot-candle = 10.76391 lumens per square meter (lm/m^2)

* Exactly.

SECTION A. DEFINITIONS OF SPECIAL TERMS

The following definitions are for use with Part 1 of the National Electrical Safety Code. For other use and for definitions not contained herein, see:

(1) NBS Handbook 81 (ANSI C2.2—1960)
(2) Definitions of Electrical Terms (ANSI C42)

NOTE: Definitions of terms marked with an asterisk (*) are defined differently in NBS Handbook 81, Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines (Part 2 of the NESC). However, except in the case of Definition A–6–CONDUCTOR, those differences are of an editorial nature. Changing technology in the electrical field has necessitated a different definition for the term "CONDUCTOR."

A–1. Alive or Live means electrically connected to a source of potential difference, or electrically charged so as to have a potential different from that of the earth. The term "live" is sometimes used in place of the term "current-carrying," where the intent is clear, to avoid repetitions of the longer term.

***A–2. Appliance** means current-conducting, energy-consuming equipment, fixed or portable; for example, heating, cooking, and small motor-operated equipment.

A–3. Automatic means self-acting, operating by its own mechanism when actuated by some impersonal influence—as, for example, a change in current strength; not manual, without personal intervention. Remote control that requires personal intervention is not automatic, but manual.

A–4. Circuit means a conductor or system of conductors through which an electric current is intended to flow.

***A–5. Circuit Breaker** means a mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal conditions such as those of short circuits.

***A–6. Conductor** means a material usually in the form of a wire, cable, or bus bar suitable for carrying an electric current.

A–7. Current-Carrying Part means a conducting part intended to be connected in an electric circuit to a source of voltage. Noncurrent-carrying parts are those not intended to be so connected.

***A–8. De-energized (Dead)** means free from any electric connection to a source of potential difference and from electric charge; not having a potential different from that of the earth.

NOTE: The term is used only with reference to current-carrying parts which are sometimes alive.

***A–9. Disconnecting or Isolating Switch (Disconnector, Isolator)** means a mechanical switching device used for changing the connec-

tions in a circuit, or for isolating a circuit or equipment from a source of power.

NOTE: It is required to carry normal load current continuously, and also abnormal or short-circuit currents for short intervals as specified. It is also required to open or close circuits either when negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the switch poles occurs.

A–10. Effectively Grounded means permanently connected to earth through a ground connection or connections of sufficiently low impedence and having sufficient current-carrying capacity to prevent the building up of voltages which may result in undue hazard to connected equipment or to persons.

A–11. Electric-Supply Equipment means equipment which produces, modifies, regulates, controls, or safeguards a supply of electric energy. Similar equipment, however, is not included where used in connection with signaling systems under the following conditions:

(a) Where the voltage does not exceed 150 volts.
(b) Where the voltage is between 150 and 400 volts and the power transmitted does not exceed 3 kilowatts.

A–12. Electrical Supply Station means any building, room, or separate space within which electric supply equipment is located and the interior of which is accessible, as a rule, only to properly qualified persons.

NOTE: This includes generating stations and substations and generator, storage-battery, and transformer rooms.

A–13. Enclosed means surrounded by a case, cage or fence, which will protect the contained equipment and prevent accidental contact of a person with live parts.

A–14. Equipment means a general term including fittings, devices, appliances, fixtures, apparatus, and the like, used as a part of, or in connection with, an electric installation.

A–15. Explosion Proof means capable of withstanding without injury and without transmitting flame to the outside any explosion of gas which may occur within.

A–16. Grounded means connected to earth or to some extended conducting body which serves instead of the earth whether the connection is intentional or accidental.

A–17. Grounded Conductor means a conductor which is intentionally grounded, either solidly or through a current limiting device.

A–18. Grounded System means a system of conductors in which at least one conductor or point (usually the middle wire, or neutral point of transformer or generator windings) is intentionally grounded, either solidly or through a current-limiting device.

A–19. Grounding Conductor means a conductor which is used to connect the equipment or the wiring system with a grounding electrode or electrodes.

A–20. Guarded means covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers or casings, barrier

rails or screens, mats or platforms, to remove the liability of dangerous contact or approach by persons or objects to a point of danger.

NOTE: Wires which are insulated, but not otherwise protected, are not considered as guarded.

A–21. Insulated means separated from other conducting surfaces by a dielectric substance or air space permanently offering a high resistance to the passage of current and to disruptive discharge through the substance or space.

NOTE: When any object is said to be insulated, it is understood to be insulated in a suitable manner for the conditions to which it is subjected. Otherwise, it is, within the purpose of these rules, uninsulated. Insulating covering of conductors is one means for making the conductors insulated.

A–22. Insulating (where applied to the covering of a conductor, or to clothing, guards, rods, and other safety devices) means that a device, when interposed between a person and current-carrying parts, protects the person making use of it against electric shock from the current-carrying parts with which the device is intended to be used; the opposite of conducting.

A–23. Isolated means that an object is not readily accessible to persons unless special means for access are used.

A–24. Isolation by Elevation means elevated sufficiently so that persons may safely walk underneath.

***A–25. Lightning Arrester** means a protective device for limiting surge voltage on equipment by discharging or by-passing surge current; it prevents continued flow of follow current to ground, and is capable of repeating these functions as specified.

NOTE: In general, arresters consist of series gaps and characteristic elements arranged within or upon suitable insulating members.

A–26. Low Voltage Protection means the effect of a device operative on the reduction or failure of voltage so as to cause and maintain the interruption of power supply to the equipment protected.

A–27. Manual means capable of being operated by personal intervention.

A–28. Qualified means familiar with the construction and operation of the apparatus and the hazards involved.

A–29. Raceway means any channel for loosely holding wires or cables in interior work, which is designed expressly and used solely for this purpose. Raceways may be of metal, wood, or insulating material, and the term includes wood and metal moldings consisting of a backing and capping, and also metal ducts into which wires are to be pulled.

A–30. Reconstruction means replacement of any portion of an existing installation by new equipment or construction. Does not include ordinary maintenance replacements.

A–31. Substantial means so constructed and arranged as to be of adequate strength and durability for the service to be performed under the prevailing conditions.

A–32. Supply Station—See Electrical Supply Station.

A–33. Switch means a device for opening and closing or for changing the connection of a circuit. In these rules, a switch will always be understood to be manually operated, unless otherwise stated.

A–34. Switchboard means a type of switchgear assembly that consists of one or more panels with electric devices mounted thereon, and associated framework.

A–35. Tags mean "men at work" tags of distinctive appearance, indicating that the equipment or lines so marked are being worked on.

A–36. Transformer Vault means an isolated enclosure either above or below ground with fire-resistant walls, ceiling, and floor, in which transformers and related equipment are installed, and which is not continuously attended during operation.

A–37. Utilization Equipment means equipment, devices, and connected wiring which utilize electric energy for mechanical, chemical, heating, lighting, testing, or similar purposes and are not a part of supply equipment, supply lines, or communication lines.

A–38. Voltage of an Effectively Grounded Circuit means the highest effective voltage between any conductor and ground unless otherwise indicated.

A–39. Voltage of a Circuit Not Effectively Grounded means the highest effective voltage between any two conductors unless otherwise indicated.

If one circuit is directly connected to another circuit of higher voltage (as in the case of an autotransformer), both are considered as of the higher voltage, unless the circuit of lower voltage is effectively grounded, in which case its voltage is not determined by the circuit of higher voltage. Direct connection implies electric connection as distinguished from connection merely through electromagnetic or electrostatic induction.

A–40. Voltage to Ground of a Grounded Circuit means the highest effective voltage between any conductor of the circuit and that point or conductor of the circuit which is grounded.

A–41. Voltage to Ground of an Ungrounded Circuit means the highest effective voltage between any two conductors of the circuit concerned.

A–42. Voltage to Ground of a Conductor of a Grounded Circuit means the highest effective voltage between such conductor and that point or conductor of the circuit which is grounded.

A–43. Voltage to Ground of a Conductor of an Ungrounded Circuit means the highest effective voltage between such conductor and any other conductor of the circuit concerned.

A–44. Wire Gages:—the American Wire Gage (AWG), otherwise known as Brown & Sharpe (B&S), is the standard gage for copper, aluminum, and other conductors, excepting steel, for which the Steel Wire Gage (Stl. WG) is used throughout these rules.

NATIONAL ELECTRICAL SAFETY CODE

Part 1. Rules for the Installation and Maintenance of Electrical Supply Stations and Equipment.

SEC. 10. PURPOSE, SCOPE AND APPLICATION OF THE RULES

100. Purpose of the Rules.

The purpose of Part 1 of this Code is the practical safeguarding of persons from hazards arising from the installation and maintenance of electrical supply stations and associated equipment. It contains basic minimum provisions considered necessary for safety. Compliance therewith will result in an installation essentially free of hazards. It is not intended as a design specification or as an instruction manual for untrained persons.

101. Scope of the Rules.

Covered:—Part 1 of this Code covers the electric conductors and equipment in electrical supply stations along with the associated structural arrangements employed, for example, by an electrical or railway utility in the exercise of its function as a utility and accessible only to properly qualified personnel. It also covers similar electric conductors and equipment in electrical supply stations when owned by and installed in an industrial establishment, where the electrical supply stations are under the control of and accessible only to properly qualified persons. Examples of such industrial establishments are the paper and steel industries.

Not Covered:—It does not cover installations in mines, ships, railway rolling equipment, aircraft, automotive equipment or the conductors and equipment used primarily for the utilization of electric power, except those in electrical supply stations. It does not cover installations in industrial or commercial establishments not under the control of and accessible only to properly qualified persons. Examples of such establishments are apartment houses and shopping centers.

102. Application of the Rules and Exemptions.

A. Application.

The rules shall apply to all installations except that they may be modified or waived by the proper administrative authority when shown to be impracticable. In such cases, equivalent or safer construction shall be secured in other ways, including special working methods. Methods of construction and installation other than those specified in the rules may also be made as experiments to obtain information, if done where proper supervision can be administered.

B. Intent of Rules.

The intent of these rules, which constitute a minimum standard, will be realized by applying the rules in full to all new installations, alterations, reconstructions, and extensions. Rules in this Code which are to be regarded as mandatory are characterized by the use of the word "shall." Where a rule is of an advisory nature, it is indicated by the use of the word "should." Other practices which are considered desirable but not intended to be mandatory are stated as recommendations. It is realized that conditions may exist which necessitate departures from such recommendations. Notes contained herein are for information purposes only and are not to be considered as mandatory or as part of the Code requirements.

C. Temporary Installations.

It will sometimes be necessary to modify or waive certain of the rules for specified limited periods of time in cases of temporary installations which are shortly to be dismantled or reconstructed.

SEC. 11. PROTECTIVE ARRANGEMENTS IN ELECTRICAL SUPPLY STATIONS

110. General Requirements.

A. Enclosure of Equipment.

Rooms and spaces in which electrical supply conductors or equipment are installed shall be so arranged with fences, screens, partitions or walls as to prevent entrance of unauthorized persons or interference by them with

equipment inside. Entrances not under observation of an authorized attendant shall be kept locked. Warning signs shall be displayed at entrances.

Metal fences, when used to enclose electrical supply stations having energized electrical conductors or equipment that can be reached by trespassers, shall be a minimum of seven feet in height and shall be effectively grounded. Other types of construction such as nonmetallic material shall present equivalent barriers to climbing or other unauthorized entry.

NOTE: It is recommended that, where permissible, a one-foot extension, carrying three strands of barbed wire, be used above the fence fabric, either as an outside or inside the fence overhang, or as a vertical extension of the fence to obtain the desired overall height.

B. Rooms and Spaces.

All rooms and spaces in which electric supply equipment is installed shall comply with the following requirements:

1. FIREPROOF CONSTRUCTION.
   They shall be, as far as practicable, noncombustible.
2. USE.
   They shall be free from combustible materials, dust, and fumes and shall not be used for manufacturing or for storage, except for minor parts essential to the maintenance of the installed equipment. (For battery rooms, see Section 14; for auxiliary equipment in hazardous locations, see Rule 127.)
3. VENTILATION.
   There should be sufficient ventilation to maintain operating temperatures within ratings and to prevent the accumulation of airborne contaminants under any operating conditions.
4. MOISTURE AND WEATHER.
   They should be dry. In outdoor stations or stations in wet tunnels, subways or other moist or high humidity locations, the equipment shall be suitably designed to withstand the prevailing atmospheric conditions.

C. Rotating Machinery.

Rotating machinery shall be installed upon suitable supports or foundations and secured in place.

111. Illumination.

A. Under Normal Conditions.

Rooms and spaces where electric apparatus or machinery is located shall have means for artificial illumination at intensities not less than given in table 1. The means of illumination shall be maintained ready for use at all times.

Table 1.—*Illumination Intensities**

Location	Minimum* Footcandles
Switchboard instruments, gages, switches, etc.	30
Storage battery room	20
Generating room, boiler room, pump room	20
Any traversed space (measured at floor level)	5

* The values are to be measured at working surfaces, except as stated.

NOTE:—It is not intended that this rule should require permanent lighting in switch cells and similar small spaces occupied by electric apparatus where permanent lighting is impractical. The IES Lighting Handbook, Fourth Edition, 1966, includes general standards of illumination required for safety.

B. Emergency Source.

A separate emergency source of illumination with automatic transfer provisions, from an independent generator, storage battery or other suitable source, shall be provided in every attended station.

C. Fixtures.

Arrangements of permanent fixtures and plug receptacles shall be such that portable cords need not be brought into dangerous proximity to live or moving parts. All lighting shall be controlled and serviced from safely accessible locations.

D. Attachment Plugs and Receptacles for General Use.

Portable conductors shall be attached to fixed wiring only through separable attachment plugs which will

disconnect all poles by one operation. Receptacles installed on two or three wire single phase, a-c branch circuits shall be of the grounding type. Receptacles connected to circuits having different voltages, frequencies or types of current (a-c or d-c) on the same premises shall be of such design that attachment plugs used on such circuits are not interchangeable.

112. Floors, Floor Openings, Passageways, Stairs.

A. Floors.

Floors shall have even surfaces and afford secure footing. Slippery floors or stairs should be provided with suitable antislip covering.

B. Passageways.

Passageways, including stairways, shall be unobstructed and shall, where possible, provide at least 6 feet, 6 inches of headroom. Where not possible, the obstruction should be painted, marked or indicated by warning signs and the area properly lighted.

NOTE:—Additional information may be obtained by referring to American National Standard Safety Code for Floor and Wall Openings, Railings and Toe Boards, A–12.1, 1967.

C. Railings.

All floor openings without gratings or other adequate cover and raised platforms and walkways in excess of one foot in height shall be provided with suitable railings. Openings in railings for units such as fixed ladders, cranes and the like shall be provided with adequate guards such as grates, chains or sliding pipe sections.

D. Stair Guards.

All stairways consisting of four or more risers shall be provided with handrails. Stairways of less than four risers shall be plainly marked in a contrasting color from the surrounding area.

NOTE:—Additional information may be obtained by referring to American National Standard Safety Code for Floor and Wall Openings, Railings and Toe Boards, A–12.1, 1967.

113. Exits.

A. Clear Exits.

Each room or space and each working space about equipment shall have suitable means of exit which shall be

kept clear of all obstructions. Exit doors shall be equipped with locks or latches that permit opening by means of simple pressure or torque on the actuating parts under any condition.

B. Double Exits.

If the plan of the room or space and the character and arrangement of equipment are such that an accident would be liable to close or make inaccessible a single exit, as in the case of long narrow rooms, platforms, passageways, spaces behind switchboards or wire and pipe tunnels, a second exit shall be provided.

114. Fire Extinguishing Equipment.

Adequate fire extinguishing equipment approved for the intended use shall be conveniently located and conspicuously marked. Fire extinguishers shall be suitable for the temperature range of the location in which they are installed.

NOTE:—Fumes from carbon tetrachloride fire extinguishers are extremely toxic and such extinguishers should not be used in enclosed locations or where the possibility of inhalation of such fumes is present.

115. Oil-Filled Apparatus.

The fire hazards associated with oil-filled transformers, regulators, switches, circuit breakers and reclosers necessitate special precautions in installation design. Installations shall be in accordance with Rule 153, "Location and Arrangement of Power Transformers," and Rule 172, "Circuit Breakers Switches and Reclosers Containing Oil."

SEC. 12. PROTECTIVE ARRANGEMENTS OF EQUIPMENT.

120. General Requirements.

All electric supply equipment shall be constructed, installed and maintained so as to reduce the life and fire hazard as far as practicable.

121. Inpections.

A. In-Service Equipment.

Electric supply equipment shall comply with these safety rules when placed in service and shall thereafter be periodically inspected and maintained. Defective

equipment or wiring shall be put in good order or permanently disconnected.

B. Idle Equipment.

Infrequently used equipment or wiring maintained for future service should be thoroughly inspected before use to determine its fitness for service.

C. Emergency Equipment.

Equipment or wiring maintained for emergency service should be periodically inspected and tested to determine its fitness for service.

D. New Equipment.

New Equipment should be thoroughly inspected and tested before being put into service.

122. Guarding Shaft Ends, Pulleys, Belts and Suddenly Moving Parts.

A. Mechanical Transmission Machinery.

This code is supplemented by the American National Standard Safety Code for Mechanical Power Transmission Apparatus, B15.1, 1953 (R–1958), which specifies methods for safeguarding pulleys, belts and other equipment used in the mechanical transmission of power.

B. Suddenly Moving Parts.

Parts of equipment which move suddenly in such a way that persons in the vicinity are liable to be injured by such movement shall be guarded or isolated.

123. Protective Grounding.

A. Protective Grounding or Isolation of Non-Current-Carrying Metal Parts.

All electric supply equipment shall have the exposed non-current-carrying metal parts, such as frames of generators and switchboards, cases of transformers, switches and operating levers effectively grounded or isolated. It is recommended that all metallic guards (including rails, screens, etc.) about electric supply equipment be effectively grounded.

B. Grounding Method.

All grounding which is intended to be a permanent and effective protective measure, such as lightning arrester grounding, grounding of circuits, equipment or wire raceways, shall be made in accordance with the methods specified in section 9 of this Code, "Methods of Protective Grounding."

NOTE:—Additional information is available in IEEE publication No. 80, "Guide for Safety in A-C Substation Grounding," dated March 15, 1961.

C. Provision for Grounding Equipment During Repairs.

Electric equipment or conductors normally operating at more than 600 volts between conductors on or about which work is occasionally done while separated from a source of electric energy by disconnecting or isolating switches only, shall be provided with some means for grounding, such as switches, connectors, or a readily accessible means for connecting a portable ground conductor. When necessary, grounding may be omitted on conductors normally operating at 25 kV or less and not influenced by higher voltage conductors, where visible openings in the source of supply are available and are properly tagged in the opening position. (See part 4 of this code.)

124. Guarding Live Parts.

A. Where Required.

1. Guards shall be provided around all live parts that are above 150 volts to ground without an adequate insulating covering, unless their location gives sufficient horizontal or vertical or a combination of these clearances to eliminate the possibility of accidental human contact. Clearances from any permanent supporting surface for workmen shall equal or exceed those shown on figure 1 and tabulated in table 2.

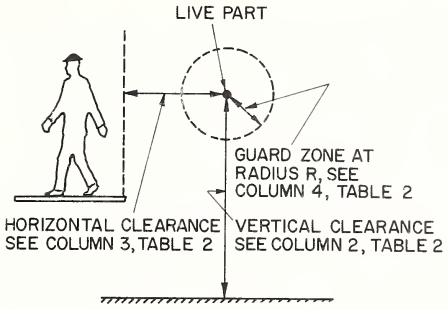
LIVE PART
GUARD ZONE AT RADIUS R, SEE COLUMN 4, TABLE 2
HORIZONTAL CLEARANCE SEE COLUMN 3, TABLE 2
VERTICAL CLEARANCE SEE COLUMN 2, TABLE 2

FIGURE 1. *Clearance from live parts.*

TABLE 2.—*Minimum clearance from live parts*

PART A—Below extra high voltages

Nominal Voltage Between Phases (1)	Minimum vertical clearance of unguarded parts (2)[1]		Minimum horizontal clearance of unguarded parts (3)[1]		Minimum clearance guard to live parts (4)[1]	
	Feet	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*
301 to 600	8	8	3	4		2
2,400	8	9	3	4		3
7,200	8	10	3	4		4
13,800	9	0	3	6		6
23,000	9	3	3	9		9
34,500	9	6	4	0	1	0
46,000	9	10	4	4	1	4
69,000	10	5	4	11	1	11
115,000	11	7	6	1	3	1
138,000	12	2	6	8	3	8
161,000	13	4	7	10	4	10
230,000	14	0	8	6	5	6

TABLE 2.—*Minimum clearance from live parts*—Continued

PART B—Extra high voltages (based on switching surge duties)[2]

Nominal voltage between phases (1)	Switching surge factor[3] per unit (A)[4]	Switching surge line to ground (B)[4]	Minimum vertical clearance of unguarded parts (2)[1]		Minimum horizontal clearance of unguarded parts (3)[1]		Minimum clearance guard to live parts (4)[1]	
		KV	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
345,000	2.2 or below	650	15	6	10	0	7	0
	2.3	680	16	0	10	6	7	6
	2.4	709	16	6	11	0	8	0
	2.5	739	17	2	11	8	8	8
	2.6	768	17	9	12	3	9	3
	2.7	798	18	4	12	10	9	10
	2.8	828	18	11	13	5	10	5
	2.9	857	19	7	14	1	11	1
	3.0	887	20	2	14	8	11	8
500,000	1.8 or below	808	18	10	13	4	10	4
	1.9	853	19	6	14	0	11	0
	2.0	898	20	6	15	0	12	0
	2.1	943	21	6	16	0	13	0
	2.2	988	22	6	17	0	14	0
	2.3	1033	23	7	18	1	15	1
	2.4	1078	24	8	19	2	16	2
	2.5	1123	25	10	20	4	17	4
	2.6	1167	27	0	21	6	18	6
	2.7	1212	28	4	22	10	19	10

PART C—Extra high voltages (based on BIL duties)[2]

Nominal Voltage Between Phases (1)	Basic Impulse Insulation[5] Level (BIL) (C)[4]	Minimum vertical clearance of unguarded parts (2)[1]		Minimum horizontal clearance of unguarded parts (3)[1]		Minimum clearance guard to live parts (4)[1]	
	KV	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
345,000	1050	15	6	10	0	7	0
345,000	1300	17	2	11	8	8	8
500,000	1550	18	10	13	4	10	4
500,000	1800	20	6	15	0	12	0

Notes to and explanations of terms used in table 2.

[1] Interpolate for intermediate values. The clearances in column 4 of this table are solely for guidance in installing guards without definite engineering design and are not to be considered as a requirement for such engineering design. For example, the minimum clearances in the table above are not intended to refer to the clearances between live parts and the walls of the cells, compartments or similar enclosing structures. They do not apply to the clearances between bus bars and supporting structures nor to clearances between the blade of a disconnecting switch and its base.

[2] Minimum clearances shall satisfy either switching surge or BIL duty requirements, whichever are greater.

[3] Switching Surge Factor—An expression of the maximum Switching Surge Crest Voltage in terms of the maximum Line to Neutral Crest Voltage of the power system.

[4] The values of columns A, B, and C are power system design factors that must correlate with selected minimum clearances. Adequate data to support these design factors should be available.

[5] BIL—Basic Impulse Insulation Level—See ANSI C–92.1—1967 for definition and application.

2. Parts over or near passageways through which material may be carried, or in or near spaces such as corridors, storerooms and boiler rooms used for nonelectrical work should be guarded or given clearances in excess of those specified such as may be necessary to secure reasonable safety. The guards shall be substantial; should where practicable completely shield or enclose, without openings, the live parts; when in spaces used for nonelectrical work should be removable only by means of tools or keys.
3. Parts of indeterminate potential, such as telephone wires exposed to induction from high voltage lines, ungrounded neutral connections, ungrounded frames, ungrounded parts of lightning arresters, ungrounded instrument cases connected directly to a high voltage circuit and the like shall, where practical, be guarded on the basis of the maximum voltage which may be present.

B. Strength of Guards.

Guards shall be sufficiently strong and shall be supported rigidly and securely enough to prevent them from being displaced or dangerously deflected by a man slipping or falling against them.

C. Types of Guards.

1. LOCATION OR ISOLATION.

Parts having clearances equal to or greater than specified in table 2 are guarded by location. Parts are guarded by isolation when all entrances to

enclosed spaces, runways, fixed ladders and the like are kept locked, barricaded or roped off and warning signs posted at all entrances, in which case no other permanent guards need be supplied.

2. METAL CABLE SHEATHS.
Effectively grounded metal cable sheaths are suitable guards except where exposed to mechanical damage. Where so exposed, metal conduit or other suitable guards should be provided.

3. SHIELDS OR ENCLOSURES.
Guards less than 4 inches outside of the guard zone shall completely enclose the parts from contact up to the heights listed in column 2 of table 2. They shall not be closer to the live parts than listed in column 4 of table 2, except when suitable insulating material is used with circuits of less than 2500 volts to ground. (See note under table 2.) If more than 4 inches outside the guard zone, the guards need not extend more than 8 feet, 6 inches above the floor. Covers or guards, which must at any time be removed while the parts they guard are live, should be arranged so that they cannot readily be brought into contact with live parts.

4. RAILINGS.
Railings are not substitutes for complete guards. If the vertical distance in table 2 cannot be obtained, railings may be used. Railings, if used, shall be located at a horizontal distance of at least 3 feet (and preferably not more than 4 feet) from the nearest point of the guard zone which is less than 8 feet, 6 inches above the floor. (See fig. 2.)

5. FENCES.
See rule 110–A–1.

6. INSULATING COVERING ON CONDUCTORS OR PARTS.
The insulating covering on parts exceeding 2500 volts to ground shall not be considered as adequate protection. For parts less than 2500 volts to ground, barriers, enclosures or insulation suitable for the voltage and conditions involved may be used. The insulation over connections shall be of a type and thickness suitable for the conditions involved.

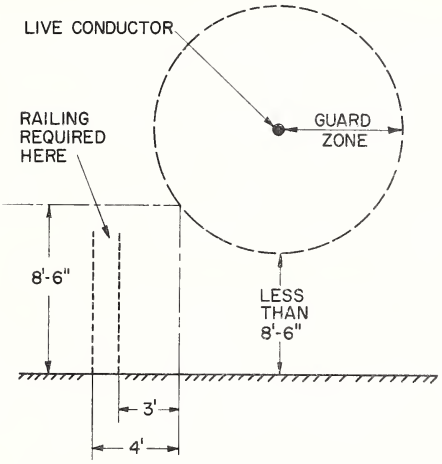

FIGURE 2. *Railing used as guards.*

7. MATS.

Mats of rubber or other suitable insulating material may be used at switchboards, switches, or rotating machinery as supplementary protection.

8. LIVE PARTS BELOW SUPPORTING SURFACES FOR PERSONS.

The supporting surfaces for persons above live parts shall be without openings. Toe boards at least 6 inches high and handrails shall be provided at all edges.

125. WORKING SPACE ABOUT ELECTRICAL EQUIPMENT.

Adequate and readily accessible working space with secure footing shall be provided about all electric parts or equipment which will require periodic adjustment or examination. A minimum of 3 feet wide by 6 feet, 6 inches high should be provided outside the guard zone.

126. EQUIPMENT FOR WORK ON LIVE PARTS.

A. Voltage from 600 to 15,000 Volts Between Phases.

When it is necessary for men to bring their bodies or any material or tools handled within the guard zone of

unguarded live parts, suitable protective equipment such as rubber gloves, rubber sleeves, insulated tools, portable rubber mats, insulated stools, rubber blankets, insulated fuse pullers, testing and grounding devices, switch sticks, insulated bucket or platform trucks and the like shall be provided, periodically inspected or tested and kept in a safe condition. Protective equipment shall be suitable for the voltage involved.

B. Voltages Over 15,000 Volts Between Phases.

Suitable protective equipment such as testing and grounding devices, switch sticks, fuse pullers, special insulated tools and insulated bucket or platform trucks shall be provided, periodically inspected or tested and kept in safe condition. Such equipment shall provide an ample margin of safety and shall have a voltage rating suitable for use on the circuit involved.

127. Hazardous Locations.

A. Enclosure of Arcing and Heating Parts.

In locations where flammable gas or flammable airborne particles exist in dangerous quantities, all parts where sparking, arcing or dangerous heating is liable to occur shall be enclosed so as to reduce the hazards as far as practicable. This enclosure shall be by one of the following methods:

1. By placing in separate compartments or rooms.
2. By using nonabsorptive, noncombustible casings of the totally enclosed type when flammable dust flyings are present.
3. By using nonabsorptive, noncombustible, explosion-proof casings when flammable gas exists in dangerous quantities.

B. Grounding.

All metal frames and other exposed noncurrent carrying metal parts of equipment in these locations shall be effectively grounded as specified in section 9.

128. Identification.

A. Method.

Electrical equipment shall be suitably identified as necessary for safety. The identification may be by position,

color, number, nameplate, design or other means, but the method of identification shall be uniform throughout any one system. Identification marks should not be placed on removable covers or doors where the interchanging of those covers or doors is possible.

B. Nameplate.

All equipment shall be provided with a nameplate in accordance with the standards applying to the equipment involved.

SEC. 13. ROTATING EQUIPMENT

NOTE:—This includes generators, motors, motor generators and rotary converters. Additional information is available in the C50 series of American National Standards and NEMA Standard MG1, 1967.

130. Speed Control and Stopping Devices.

A. Automatic Overspeed Tripping Devices for Prime Movers.

Prime movers driving generating equipment shall be provided with automatic overspeed tripping devices in addition to their governors, where harmful overspeed can occur.

B. Other Stopping Devices.

Stopping devices, such as switches or valves which can be operated from locations convenient to machine operators, shall be provided for all prime movers and for motors driving generating equipment. These devices shall be of the fail-safe type.

Controls to be used in emergency for machinery and electric equipment should be so located as to permit operation with minimum of danger during such emergency.

C. Speed Limit for Motors.

Machines of the following types shall be provided with speed-limiting devices unless their inherent characteristics or the load and the mechanical connection thereto are such as to safely limit the speed, or unless the machine is always under the manual control of a qualified operator.

1. Separately excited direct-current motors.

2. Series motors.
3. Motor-generators and converters which can be driven at excessive speed from the direct-current end, as by a reversal of current or decrease in load.

NOTE:—The required limitation of speed may be obtained by the use of a relay, centrifugal switch, or other similar device which will operate to cut off the supply of energy when excessive speed is attained.

D. Low-Voltage or Under-Voltage Protection.

All motors so employed or arranged that an unexpected starting of the motor is a hazard shall be equipped with low-voltage protection. This shall automatically cause and maintain the interruption of the motor circuit when the voltage falls below an operating value. This rule does not apply to those motors with an emergency use and where the opening of the circuit may cause a greater hazard.

E. Adjustable-Speed Motors.

Adjustable-speed motors, if controlled by means of field regulation, shall, in addition to the provisions of 130–C, be so equipped and connected that the field cannot be weakened sufficiently to permit a dangerous speed.

F. Protection of Control Circuits.

Where speed-limiting or stopping devices are electrically operated, the control circuits by which such devices are actuated shall be in conduit or otherwise suitably protected from mechanical damage. Such devices shall be of the fail-safe type.

131. Guards for Rotating Equipment.

A. Moving Parts.

Guards for moving parts shall be provided in accordance with rule 122.

B. Live Parts.

Guards for live parts shall be provided in accordance with rule 124.

132. Access to Equipment.

Where necessary, steps and handrails shall be installed on or about large machines to afford ready access to parts which must be examined or adjusted during operation.

133. Motors.

A. Control.

If the starting is automatic, as for example, by a float switch, or if the starting device or control switch is not in sight of or more than 50 feet distant from the motor and all parts of the machinery operated, the starting arrangement shall be designed so that it can positively be kept open by means of locks or equivalent devices.

B. Motors in Hazardous Locations.

Motors, with their auxiliary equipment, at which sparking or arcing or high temperature is liable to occur, if in rooms normally containing explosives, flammable gases or airborne particles, shall be so installed as to reduce the hazard by any of the following means:

1. Enclosure in an adequately ventilated separate compartment.
2. Total enclosure of the equipment.
3. Use of explosion-proof type of equipment.

Motors, when located in dusty locations, should be of the totally enclosed type or equipped with filters.

134. Hydrogen Cooled Equipment.

NOTE:—Hydrogen-air mixtures between 4.1 percent and 74.2 percent are explosive. Any gas under high pressure (at normal temperatures) in a bottle, will explode the bottle if its pressure is raised by the application of heat beyond the capability of the bottle to withstand bursting.

A. Control Equipment.

Hydrogen cooled equipment shall be controlled so as to maintain the proper hydrogen pressure automatically and shall maintain hydrogen purity of at least 95 percent. Instrumentation to indicate the percent of hydrogen in the generator shall be provided.

Hydrogen-cooled equipment shall be provided with an inert gas system which will allow exhaust and admission of hydrogen without formation of explosive mixtures.

B. Hydrogen Storage.

Hydrogen should be stored in an open air area convenient to the station. The area should be roofed to prevent direct sunlight from heating the containers. No source of ignition should be permitted in the area. Smok-

ing shall be prohibited in the vicinity and adequate warning signs posted.

C. Wiring.

All wiring and lighting fixtures in hydrogen storage areas shall be of the explosion-proof type. Electric lighting fixtures shall be mounted in a fixed position and guarded against breakage. Extension cords or portable electrical appliances shall not be used and electric switches and convenience outlets shall not be installed in the storage area.

SEC. 14. STORAGE BATTERIES

140. General.

The provisions of this section are intended to apply to all stationary installations of storage batteries, both sealed and unsealed. For operating precautions, see part 4 of this Code.

141. Location.

Storage batteries shall be so located as to be accessible only to properly qualified persons. Separate battery rooms shall be required only for unsealed jars and tanks.

142. Ventilation.

Provision shall be made for sufficient diffusion of the gases from the battery to prevent the accumulation of an explosive mixture.

143. Racks and Trays.

A. Racks.

Racks refer to frames designed to support cells or trays. They shall be substantial and made of:

1. Wood, so treated as to be resistant to deteriorating action by the electrolyte; or
2. Metal, so treated as to be resistant to deteriorating action by electrolyte and provided with nonconducting members directly supporting the cells; or with suitable insulating material on conducting members; or
3. Other similar suitable materials and construction.

B. Trays.

Trays refer to frames such as crates or shallow boxes usually of wood or other nonconducting material so constructed or treated as to be resistant to deteriorating action by the electrolyte.

Cells of the alkali type in jars of conducting material shall be supported singly, or in groups assembled in nonconducting trays, on porcelain or other suitable insulators.

144. Guarding Live Parts.

A. Guarding.

The arrangement of cells and connections shall be such that any two current-carrying parts between which a voltage exceeding 150 exists shall be properly guarded if the parts are otherwise so exposed that persons are liable to make accidental contact with both at the same time.

B. Bare Conductors.

No bare conductor shall be placed in any passageway, unless guarded or isolated by elevation.

C. Details of Guards.

Required guards shall comply with rule 124.

145. Floors in Battery Rooms.

It is recommended that floors of battery rooms be of acid-resistive material, or be painted with acid-resistive paint, or otherwise protected.

146. Wiring in Battery Rooms.

Bare conductors, open wiring, conductors in rigid conduit, electrical metallic tubing or cable with a sheath compatible with the electrolyte shall be used as the wiring method. Rigid metal conduit or electrical metallic tubing, where used, shall be of corrosion resistant material or shall be suitably protected from corrosion.

147. Illumination and Heating for Battery Rooms.

A. Lighting Fixtures.

Lighting fixtures shall be protected from physical damage by suitable guards or by isolation. Receptacles for attachment plugs and lighting switches should be located outside of battery rooms.

B. Heating Appliances.

It is recommended that heating appliances not be installed in battery rooms. Where such installation is necessary, heaters should generate temperatures that will not cause ignition of the gases present. Heater thermostats should not be installed in the battery room, unless they are installed in an explosion-proof housing.

SEC. 15. TRANSFORMERS AND REGULATORS

150. Current-Transformer Secondary Circuits Protection When Exceeding 600 Volts

Secondary circuits, when in a primary voltage area exceeding 600 volts should, except for short lead lengths at the terminals of the transformer, have the secondary wiring adequately protected by means of grounded conduit or by a grounded metallic covering. Current transformers shall have provision for shorting the secondary winding.

151. Grounding Secondary Circuits of Instrument Transformers.

The secondary circuits of instrument transformers shall be effectively grounded except where functional requirements do not permit the grounding of such circuits.

152. Grounding of Cases.

The metal case or exposed frame of each transformer, reactor, regulator and similar equipment shall be grounded or isolated in accordance with rule 123–A.

153. Location and Arrangement of Power Transformers and Regulators.

A. Outdoor Installations.

1. A transformer or regulator may be installed on a pad or foundation at ground level, provided that all live parts are enclosed so as to be inaccessible to unauthorized persons and the transformer case grounded in accordance with rule 123 or within an outdoor enclosure meeting the requirements of rule 110, such that unauthorized persons cannot come in contact with any part of the case or wiring.

2. Large oil-filled transformers should be segregated or protected by the following methods, to minimize fire hazards.

   Proportional to the amount of oil contained, space separations, fire resistant barriers, automatic extinguishing systems, absorption beds, and enclosures which confine the oil of a ruptured transformer tank are recognized safeguards. One or more of these safeguards shall be applied according to the degree of fire hazard involved.

B. Indoor Installations.

1. Transformers and regulators containing flammable liquid and located indoors shall be installed in rooms or vaults separated by fire walls from the balance of the building and with adequate ventilation to the outside. Doorways that communicate with the interior of a building shall be equipped with fire doors and shall have curbs to contain spilled oil. Floor drains shall be provided to carry oil to a safe location outside the building. Installation of a fixed fire extinguisher system of the water fog, dry chemical or CO_2 type is recommended. In unattended stations, the system should be automatically actuated.
2. Transformers or regulators of the dry type, or containing a nonflammable liquid or gas may be installed in a building without a fireproof enclosure. When installed in a building which is used for other than station purposes, the case or enclosure shall be designed so that all live parts are enclosed and the case grounded in accordance with rule 123. As an alternate, the entire unit may be enclosed so that unauthorized persons cannot come in contact with any part of the case or wiring. Where installed in a poorly ventilated location, the pressure relief vent of a unit containing an askarel liquid should be vented to the outside of the building or furnished with a means for absorbing toxic gases.

SEC. 16. CONDUCTORS

160. Electrical Protection

Conductors shall be suitable for the location, use and voltage.

A. Overcurrent Protection Required.

Conductors shall be protected against excessive heating by the design of the system and by suitable overcurrent protection.

B. Grounded Conductors.

Conductors normally grounded for the protection of persons shall be arranged without overcurrent protection or other means which could interrupt their continuity to ground.

161. Mechanical Protection.

All conductors shall be adequately supported to withstand forces caused by the maximum short circuit current to which they may be subjected.

Where exposed to mechanical damage, suitable casing, armor or other conductors, their insulation or supports.

162. Isolation.

All non-shielded insulated conductors of more than 2,500 volts to ground and bare conductors of more than 150 volts to ground, shall be isolated by elevation or guarded in accordance with rule 124.

163. Conductor Terminations.

A. Insulation.

Ends and joints of insulated conductors, unless otherwise adequately guarded, shall have equal insulating covering with other portions of the conductor.

B. Metal-Sheathed or Shielded Cable.

Insulation of the conductors where leaving the metal sheath or shield, shall be thoroughly protected from mechanical damage, moisture and electrical stress by means of a pothead or other suitable method.

SEC. 17. SWITCHES, CIRCUIT BREAKERS, FUSES AND RECLOSERS

170. Arrangement.

Switches, circuit breakers, fuses and reclosers shall be so installed as to be accessible to authorized persons for operation and maintenance. Walls, barriers, latched doors or other means shall be provided to protect the operator from live parts or from explosion or fire. Conspicuous marking shall be provided at the device and at any remote operating points to identify the equipment controlled. When the contact parts of a switching device are not normally visible, it shall be equipped with an indicator to show all normal operating positions.

171. Application.

Switches, circuit breakers, fuses and reclosers should be utilized with due regard to their assigned ratings of voltage and continuous and momentary currents. Circuit breakers, fuses and reclosers which perform a fault current interrupting function should be capable of safely interrupting the maximum short circuit current available from the system at the point of application.

172. Circuit Breakers, Switches, and Reclosers Containing Oil

Circuit interrupting devices containing flammable liquids shall be adequately segregated from other equipment and buildings to limit damage in the event of an explosion or fire. Segregation may be provided by spacing, by fire resistant barrier walls or by metal cubicles. Gas relief vents should be equipped with oil separating devices or piped to a safe location. Means should be provided to control oil which may be discharged from vents or by tank rupture. This may be accomplished by absorption beds, pits, drains, or by any combination of these. Buildings or rooms housing this equipment should be of fire resistant construction.

173. Switches and Disconnecting Devices.

A. Capacity.

Switches shall be of suitable voltage and ampere rating for the circuit on which they are installed. Switches used to break load current should be marked with the current which they are rated to interrupt and the current against which they are rated to be closed. It is recommended that switches that are not rated to interrupt the full load of the circuit be interlocked with circuit breakers to prevent the possibility of the switches being opened under load.

B. Provisions for Disconnecting.

Remotely controlled switches, oil switches and disconnectors shall be so arranged that they can be secured in the open position or plainly tagged to prevent inadvertent closing while work is being done on equipment controlled by them. The control circuit shall be provided with a positive disconnecting means near the apparatus to prevent accidental operation of the mechanism.

For switches and disconnectors, the accidental opening of which may cause a hazard, similar arrangements are desirable for retaining them in the closed position.

Provision for locking switches is recommended wherever parts of equipment are remote from the point of control.

NOTE:—See part 4 of this Code for method of de-energizing equipment or lines.

C. Visible Break Switch.

A visible break switch or disconnector shall be inserted in each ungrounded conductor between electric supply equipment or lines and sources of energy of more than 600 volts, if the equipment or lines may have to be worked on without protective grounding while the sources may be alive.

Where metal clad switchgear equipment is used, the withdrawn position of the circuit breaker, where clearly indicated, constitutes a visible break for this purpose.

174. Disconnection of Fuses.

Fuses in circuits of more than 150 volts to ground or more than 60 amperes shall be arranged so that before handling:

1. The fuses can be disconnected from all sources of electric energy, or
2. The fuses can be conveniently removed by means of insulating handles.

SEC. 18. SWITCHBOARDS

180. Location and Accessibility.

A. General Location.

Switchboards shall, where practicable, be so placed that the operator will not be endangered by any live or moving parts of machinery or equipment. They shall be so placed as to reduce to a minimum the danger of communicating fire to adjacent combustible material.

B. Spaces About Boards.

The space back of the board shall be kept clear and shall not be used for storage.

C. Arrangements.

Switchboards shall be of the dead-front type and shall have all devices so arranged that the points of control are readily accessible to the operator. Instruments, relays and other devices requiring reading or adjustments should be so placed that work can readily be performed from the working space.

181. Material.

Switchboards shall be made of noncombustible and moisture-resistant material.

182. Instrumentation and Control.

Switchboards which control generating equipment or outgoing supply circuits shall be equipped with such instruments and control equipment as may be necessary for safe and proper operation.

183. Arrangement and Identification.

Connections, wiring, and equipment of switchboards and panel-boards shall be arranged in an orderly manner. All switches, fuses, and circuit-breakers shall be plainly marked, labeled, or arranged so as to afford ready means for identifying circuits or equipment.

184. Spacings and Barriers.

Protection or separation of live parts by suitable barriers is recommended where the voltage exceeds 600 volts between conductors. It is recommended that such parts, including bus bars, should be so located, or provided with insulating coverings or barriers, that parts at different potentials will not be readily short-circuited by tools or other conducting objects.

185. Instrument Cases.

If mounted on switchboards, metal cases of instruments shall be grounded or enclosed in suitable covers which are either of grounded metal or of insulating material.

SEC. 19. LIGHTNING ARRESTERS

190. General Requirements.

Suitable precautions should be taken to protect station equipment against lightning or excessive over-voltages. Lightning arresters shall be located as close as practical to the equipment they protect.

191. Indoor Locations.

Lightning arresters, if installed inside of buildings shall be enclosed and shall be located well away from passageways and combustible parts.

192. Grounding Conductors.

Grounding conductors shall be run as directly as possible between the arresters and ground and be of low impedance and ample current-carrying capacity. (See sec. 9 for methods of protective grounding.)

193. Guarding Live Parts.

See rule 124.

194. Installation.

Lightning arresters shall be installed in such a manner and location that the expulsion of gases or disconnection of the ground lead isolator is not directed upon live parts in the vicinity.

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This Handbook contains Part 1 of the National Electrical Safety Code and supersedes NBS Handbook H31 and pages 31 through 75 of NBS Handbook H30. Part 1 of this Code covers the electric conductors and equipment in electrical supply stations along with the associated structural arrangements employed, for example, by an electrical or railway utility in the exercise of its function as a utility and accessible only to properly qualified personnel. It also covers similar electric conductors and equipment in electrical supply stations when owned by and installed in an industrial establishment, where the electrical supply stations are under the control of and accessible only to properly qualified persons. Examples of such industrial establishments are the paper and steel industries.

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